

## AECIAL STAGE OF PUCCINIA OXALIDIS

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In July 1915 the junior writer collected an undescribed *Aecidium* on the leaves of *Berberis repens* in Bear Canyon, located in the Sandia Mountains about 15 miles east of Albuquerque, New Mexico. At the time the *Aecidium* was discovered no clue was found as to what hosts might harbor the alternate stages of this rust. The marked differences in the microscopic characters of the new *Aecidium* easily separated it from the aecial stage of both *Puccinia graminis* and *P. koeleriae*, the only two other rusts known to occur on species of *Berberis*. The first assumption was that this new rust might have its alternate stage on some graminaceous host, but careful field work in the spring of 1916 by the senior author soon dispelled this theory, since this *Aecidium* was often found abundantly in localities where there were no possible grass hosts. Field observations showed that this rust always occurred in localities where plants of *Oxalis violacea* and *Berberis repens* were closely associated, and when they were not associated no rust was found on the *Berberis*. Later in the spring of 1916 the senior writer found young leaves of *Oxalis violacea* bearing the primary urediniospores of *Puccinia oxalidis* in direct contact with the old aecia which had sporulated. This association of the two rusts was constant throughout the canyons in the Sandia Mountains, where the two hosts occurred in proximity to each other, while neither rust was found on either host when the hosts were widely separated.

With this positive field clue as a guide, inoculations were made at Tejano Experiment Station, in the Sandia Mountains, about 30 miles from Albuquerque, on 10 wild plants of *Berberis repens* growing in the open. After thoroughly wetting the plants, living old leaves of *Oxalis* bearing germinating teliospores of *Puccinia oxalidis* were placed above young leaves of *Berberis*. Both inoculated and check plants were protected by placing tin cans over them. These inoculations were made September 20, 1916. The tin cans were removed September 23. On October 20 the 10 inoculated



plants were examined and all of them were found to be infected; some so badly that the leaves were dying, while all (6) of the check plants were healthy. At this date pycnia only were present, exuding droplets of a sweetish sticky fluid like honey-dew. Another trip was made to the Station June 30, 1917, when the inoculated leaves showed well developed aecia, while the check plants were still free of the rust. These inoculations were not considered absolutely conclusive, however, since the *Berberis* plants inoculated were in the open and therefore subject to external contamination.

In the fall of 1916 bulbs of *Oxalis violacea* were transferred from the mountains to Albuquerque, a distance of some 15 miles from any *Berberis* plants, and therefore free from any possible external contamination. Fresh but non-sporulating material of the *Aecidium* on *Berberis* was obtained from Bear Canyon June 22, 1917. At this time no *Oxalis* plants had appeared above ground in the vicinity of the infected *Berberis* leaves in the Canyon, but the *Oxalis* plants transferred to Albuquerque the preceding fall were in full leaf. The infected *Berberis* leaves were moistened and kept overnight under a bell jar to start sporulation. On June 23 two species of *Oxalis* (*O. violacea* and *O. stricta*) were inoculated under control conditions with the aeciospores from *Berberis*. Bell jars were kept over the plants 60 hours. Checks were also made. On June 30 many of the inoculated leaves of *O. violacea* had the typical uredinia of *Puccinia oxalidis*, while the check plants as well as all plants of *O. stricta* were free of the rust. July 22 telia were present on the inoculated leaves of *O. violacea*. The inoculations here reported, together with those made at the Tejano Experiment Station, prove conclusively that the new *Aecidium* on *Berberis repens* is the alternate stage of *Puccinia oxalidis*, a description of which is herewith given.

#### PUCCINIA OXALIDIS (Lev.) Diet. and Peck

O. Pycnia amphigenous but mainly epiphyllous, seated on pallid to slightly reddish spots 4-8 mm. in diameter, conspicuous, conic-globoid, honey-yellow becoming blackish brown, appearing in the fall of the year when the pycnospores are discharged in a



sweetish sticky liquid. In the spring when the aecia appear the pycnia are blackish brown.

I. Aecia hypophyllous, seated on pallid to reddish brown spots which later become dark brown, crowded in irregular annular groups 4–8 mm. across, aecia orange color when fresh, cylindrical, 1–1.25 mm. high by 0.15 to 0.2 mm. in diameter, peridium opening at apex very irregularly, very slow to open and very tough, segments slightly if at all reflexed, usually falling away piecemeal, peridial cells not overlapping, in face view irregularly oblong to polygonal,  $10-17 \times 17-27 \mu$ , in side view pulvinate  $14-17 \times 20-24 \mu$ , inner wall verruculose 2–2.5  $\mu$  thick, outer wall irregularly striate, 3–4  $\mu$  thick, walls colorless, content of cells orange; aeciospores irregularly oval, ovate to subglobose, angular,  $10-13 \times 13-17 \mu$ , average for ten,  $11 \times 14.4 \mu$ ; walls colorless, faintly verruculose to smooth, 1.5–2  $\mu$  thick, pores indistinct.

On Berberidaceae: *Berberis repens* from New Mexico as follows: Bear Canyon by R. M. Harsch, July 7, 1915 (no. 5554);<sup>1</sup> by Bartholomew and Long, June 22, 1917 (no. 6281), material used for inoculating *Oxalis violacea* plants; by Long, August 2, 1917 (no. 6284); Tejano Experiment Station, by Long and Seay, June and July 1916 (nos. 6005, 6006, 6021, 6097); by Long, July 1917 (no. 6285), material obtained by inoculating *Berberis* plants September 20, 1916, with teliospores of *Puccinia oxalidis* from *Oxalis violacea* July 1917 (no. 6286).

II. Uredinia hypophyllous, subepidermal, in irregular to orbicular groups 2–6 mm. across, often confluent and covering entire surface of leaf, round, 0.1–0.3 mm. across, soon naked, at first orange buff and waxy, later fading somewhat and becoming pulverulent, ruptured epidermis inconspicuous; urediniospores globoid or elliptical globoid,  $15-20 \times 17-25 \mu$ ; walls thin, about 1  $\mu$ , minutely echinulate, germ pores uncertain.

III. Telia hypophyllous, in orbicular to irregular groups 2–5 mm. across, often confluent over entire leaf surface, subepidermal, ruptured epidermis inconspicuous, soon naked, orange buff, waxy, round, 0.1–0.3 mm. across. Teliospore ellipsoid to oval,  $12-22 \times 17-28 \mu$ , rounded or obtuse at both ends, slightly or not at all constricted at septum; septum often oblique; walls colorless,

<sup>1</sup> All herbarium numbers cited in this article refer to the herbarium numbers of the senior writer.



smooth, thin, less than  $1\ \mu$  thick; pedicel colorless, thick, about as long as spore.

On Oxalidaceae: *Oxalis violacea* from New Mexico as follows: Albuquerque, by Long, July 1917 (no. 6282), material obtained by inoculating with aeciospores from *Berberis repens* June 20, 1917; Tejano Experiment Station, by Long and Seay, July and September 1916 (nos. 6014, 6100, 6102). Also reported on following hosts: from Jamaica, *Oxalis martiana*; from Mexico, *Oxalis divaricata*, *O. latifolia*, *O. tetraeuris*, *O. trinervis*, *O. vallicola*, *Oxalis* sp.; from Texas, *O. violacea*; from Brazil, *O. neuwiedii*.

The roestelia-like aecia and other characters of this rust indicate its relationship in a general way to the genus *Gymnosporangium*, while some of its characters show affinity for the genus *Eriosporangium*, from which, however, its very tough, persistent peridium would exclude it. It does not belong to the genus *Argomyces*, where ARTHUR has provisionally placed it. If one were following ARTHUR's nomenclature, the rust would probably belong to a new genus, but the writers prefer to leave it under the old genus *Puccinia* for the present.

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